TITLE: CONTROL OF INTERFACIAL DUST CAKE TO IMPROVE EFFICIENCY OF MOVING BED GRANULAR FILTERS

PIs: Robert C. Brown and Gerald Colver

STUDENTS: Saw-Choon Soo, Matt Birmont, and Andrew Strohm

INSTITUTION: Iowa State University
Center for Sustainable Environmental Technologies
285 Metals Development Bldg.
Ames, IA 50011-3020
Tel: 515-294-7934
Fax: 515-294-3091
E-mail: rcbrown@iastate.edu

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ABSTRACT

OBJECTIVE

The objective of this research is to improve the performance of moving bed granular filters for hot gas clean up. Granular bed filters are attractive because they employ low-cost refractory particles as filter media and offer the prospect for constant pressure drop.

Based on observations by other researchers that formation of dust cake is important to efficient dust collection for fixed bed granular filters, we have developed a new concept for a moving bed granular filter. The goal is to establish a quasi-steady dust cake that is continuously renewed on the upstream side of the dust cake and swept away on the downstream side. The advantage of a quasi-steady dust cake is avoidance of periodic variation in efficiency and pressure drop inherent in most barrier filters.

Specific objectives of this research include:

- Understand the interfacial phenomena of dust cake formation in moving bed filters
- Develop performance correlations applicable to high temperatures and pressures
- Develop granular filters that exploit dust cakes to improve collection efficiency

ACCOMPLISHMENTS TO DATE

This annual report covers the period from the start of the project, July 1, 1999, to December 31, 1999. Work to date has concentrated on constructing experimental equipment and designing instrumentation required for the project.
We have completed design of a moving bed with axially symmetric flow suitable for parametric evaluations of filter performance. Original plans to use an existing Plexiglas moving bed granular filter were scrapped when it was realized that the Plexiglas shell could not handle the slightly elevated pressures (on the order of 20 psig) planned for some of the similitude evaluations. Also, the original filter body was not large enough to accommodate the desired interfacial area between the granular material and the gas. In its place, we have designed a similar but slightly larger filter to be constructed of aluminum.

Our design calls for an auger to feed fly ash into the inlet line. The auger feed rate can be calibrated to give a rough estimate of particulate concentrations; isokinetic sampling will be employed for accurate measurements. Since concentration measurements using isokinetic sampling is an off-line technique, we are also designing an on-line technique based on optical extinction measurements. Two He-Ne operated in conjunction with two photodiodes will be used to measure particle concentrations in the entering and exiting gas flows. Beers Law relates the light attenuation to the particle concentration if the size distribution of particles is invariant with time. This invariance requires careful control of fly ash size added to the auger feeder. Isokinetic sampling will be used to check this assumption on a periodic basis.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

Advanced coal-fired power cycles under development by the U.S. Department of Energy include pressurized fluidized bed combustion and integrated gasification/ combined cycles based on gas turbines and fuel cells. All of these advanced cycles are premised on the efficient removal of fine particles from high temperature, high pressure (HTHP) gas streams. Recent analyses suggest that granular bed filters are among the most promising approaches to hot-gas clean up for advanced coal conversion technologies. Granular bed filters are attractive for hot gas filtration because they employ low-cost refractory granules as filter media.

PLANS FOR THE COMING YEAR

- Final assembly of the experimental system will be completed
- Similitude theory will be employed in the design of experiments that can be performed at conditions close to ambient while simulating the hydrodynamic conditions associated with high temperature, high pressure gas flows.

ARTICLES, PRESENTATION, AND STUDENT SUPPORT

Journal Articles (peer reviewed): None

Conference Presentations: None

Students Supported under this Grant

- Saw-choon Soo, graduate student in mechanical engineering, Iowa State University
- Matt Birmont, undergraduate student in mechanical engineering, Iowa State University
- Andrew Strom, undergraduate student in chemical engineering, Iowa State University